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DIFFERENCES BETWEEN THE TRICON V9.5.3 SYSTEM AND THE TRICON V10.2.1 SYSTEM

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1.0 Introduction

This document has been created specifically for the purpose of describing the hardware and software differences between the Tricon V9.5.3 system (the current V9 system identified in the existing SER) and the Tricon V10.2.1 system. The information in this document is derived from various internal formal requirements and/or design documents, nuclear qualification documents, etc. References that will be cited often in this document include:

- 9600164-545, Rev 3, Equipment Qualification Summary Report (EQSR)
- 9600164-539, Rev 1, Critical Digital Review (CDR)
- 9600164-535, Rev 1, Software Qualification Report (SQR)
- 9100278-001, Rev1.2, Differences between the TRICON 9.52.1 System and the TRICON 10.2.4 System and V&V Summary
- 9100041-001, rev 17, Triconex Nuclear Qualified Equipment List (Tricon v9 NQEL)
- 9100150-001, rev 6, Tricon v10 Nuclear Qualified Equipment List (Tricon v10 NQEL)

This document is not a specification for the Tricon systems. If there is any discrepancy between this document and the formal documents, the formal documents shall prevail.

1.1 Background

Invensys initiated the Tricon V10.2.1 Nuclear Qualification Upgrade Project to address the contingencies identified in *Triconex Topical Report 7286-545-1-A, Qualification Summary Report* and the *NRC Safety Evaluation Report (SER)* dated December 12, 2001 (ADAMS Accession Number ML013470433). NRC staff noted that the Tricon PLC system did not fully meet the guidance of TR-107330 for seismic, EMI/RFI conducted and radiated emissions, surge withstand, and ESD withstand, requiring the nuclear power plant engineering staff to verify that reported results envelop the specific plant application.

Recognizing that such requirements increase plant contingencies, Invensys initiated modifications of the Tricon to elevate its performance to that required in TR-107330 and the recently issued R.G. 1.180, Revision 1. In addition to EMC hardening of components, Invensys also introduced new processors and features, which required evaluation and verification and validation testing.

The Tricon V10.2.1 system has been developed in accordance with approved Invensys processes and procedures. These processes and procedures are substantially the same as those that were reviewed and approved as part of the V9.5.3 SER issuance, but have since been strengthened based upon Continuous Process Improvement principles and best practices.

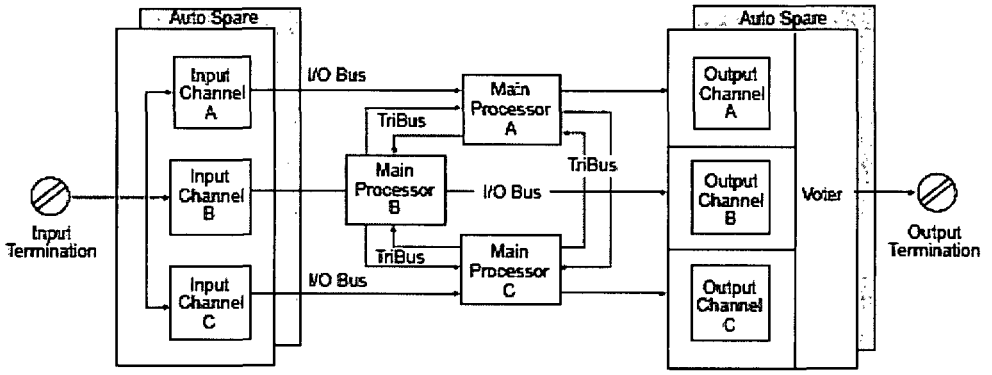
As part of the product development cycle, all Tricon system versions after V9.5.3 have been verified and validated at the system, subsystem, and module levels by the Triconex Product

Assurance group and by an independent, external third party (TÜV), as per Invensys processes and procedures.

Invensys is interested in mitigating project risk and schedule risk for both our customers and ourselves. We believe we can do this by adhering to guidelines proposed by the NRC in recent public forums and ANS meetings. By requesting the NRC to revise its safety analysis to reflect upgrade of the Tricon V9.5.3 to the Tricon V10.2.1, we will enable a licensee to propose an approved platform that is currently within the boundaries of its approval, as described in the topical report. We believe this will decrease the risk to our customers and potentially minimize the review cycle.

1.2 System Architecture & System Level Differences between V9.5.3 & V10.2.1

Section 2 of the SER describes the Tricon V9.5.3 system architecture. The Tricon V10.2.1 system architecture is the same as that of the previously qualified Tricon V9.5.3 system. The following figure, also in the SER, shows the Triple Modular Redundant (TMR) architecture of all Tricon systems:



The TriStation 1131 application programming model architecture for the Tricon V10.2.1 system is the same as that of the previously qualified Tricon V9.5.3 system.

Since the time the SER was issued, the Tricon V9.5.3 has had some enhancements as well as maintenance upgrades. The CDR (Triconex report 9600164-539, Rev 1) provides additional details on the history of upgrades to V9.5.3. For the list of new or upgraded modules that went through qualification testing for the Tricon V10.2.1, see section 3.3 of the EQSR (Triconex report 9600164-545, Rev 3).

The Tricon V10.2.1 system includes the following **new modules**:

- A new Main Processor (Model 3008N):
  - Two 50 MHz, 32-bit Freescale Semiconductor MPC860EN microprocessors along with 25 Mb/second Tribus provides quadruple performance of the V9.5.3 Main Processor (Model 3006N).
  - 16 Mbyte of DRAM versus 2 Mbyte of static RAM for the application and Sequence of Events Data
  - See EQSR section 3.1.6, and CDR sections 3.1.1 thru 3.1.5, and 3.1.8
- New SMT-based I/O modules (AI 3721N and DO 3625N):
  - These are next generation I/O modules that use the same basic TMR (Triple Modular Redundant) architecture of the previous I/O modules. The interface to the I/O bus and I/O protocol for communication to the MP is the same as previous I/O modules.
  - Each channel (leg) of the module has an ATMEL AT91R40008 ARM microcontroller and a Xilinx Spartan IIE 1.8V Field Programmable Gate Array (FPGA). Each channel has a separate 2 MB flash memory. The microprocessor's 16-bit bus connects to the FPGA and flash memory.
  - The 3721N AI module provides the following advantages over the previous AI modules for the Tricon V9.5.3 system:
    - A 10 msec scan rate for all the field inputs, compared to the 50 msec scan rate for all the field inputs of previous AI modules (such as the 3700AN).
    - Can be configured for unipolar input (0 to 5 VDC) or bipolar input (-5 to +5 VDC).
    - 14-bit resolution, versus the 12-bit resolution of previous AI modules.
  - The 3625N DO module provides the following advantages over the previous DO modules for the TriconV9.5.3 system:
    - 32 output points, compared to 16 points for the old modules
    - Can be configured as supervised or unsupervised
  - Replace the following V9.5.3 modules:
    - AI 3700AN (0-5 VDC) and AI 3704EN (0-5/0-10 VDC, High Density)
    - DO 3604EN (24 VDC) and DO 3624N (24 VDC, Supervised)
  - See CDR section 3.2 for a detailed discussion of the next generation I/O modules
- AO 3805HN (4-20 mA) module:
  - Supports increased inductive loads
  - Replaces AO 3805EN (4-20 mA)
- PI 3511N – New Pulse Input module:
  - Faster input scan

- Based on existing PI 3510N module
- Existing Through Hole I/O modules converted to SMT modules (Form, fit, and function compatible)
  - 3701N (0-10 VDC) - Through Hole to 3701N2 (0-10 VDC) – SMT
  - 3501TN 115V AC/DC – Through Hole to 3501TN2 115V AC/DC – SMT
  - 3502EN 48V AC/DC – Through Hole to 3502EN2 48V AC/DC – SMT
  - 3503EN 24V AC/DC – Through Hole to 3503EN2 24V AC/DC – SMT
- A new communication module (TCM 4325AN Fiber Optic):
  - Combines the functionality of the three Tricon V9.5.3 communication modules (EICM 4119AN, NCM 4329N, and ACM 4609N)
  - Improves communication capabilities, including MODBUS TCP protocol support.
  - See CDR section 3.3 for a detailed description of the TCM 4325N; additionally, Appendices A and B to the CDR provide the results of rigorous review of the TCM against NRC requirements

1.3 Summary of Differences

Section 1.0 of the SER contains a list of Tricon V9.5.3 modules approved for use in safety-related applications. The SER also contains a table titled "Safety-related Sofware" in Section 2.2.1 (page 18) that lists software for each Tricon V9.5.3 module, including version numbers. The tables in the following sections compare Tricon V9.5.3 and V10.2.1 hardware modules (section 1.3.1) and software versions (section 1.3.2). See section 3.3 of the EQSR for the list of components that went through qualification testing for Tricon V10.2.1. All components qualified for safety-related use are on the NQEL. Detailed discussions are provided in the CDR on the Main Processor modules (section 3.1), I/O modules (section 3.2), and the communications module (section 3.3).

1.3.1 Hardware

Module	Tricon V9.5.3 System	Tricon V10.2.1 System
Main Processor	3006N	3008N
	Hardware floating point processor	Embedded floating point software
Communication Module	Three modules: ▪ 4119AN (EICM) ▪ 4329N (NCM) ▪ 4609N (ACM)	One module: ▪ 4352AN (TCM) Fiber Optic
I/O Modules Analog Input (AI)	3700AN (0-5 VDC)	3721N (0-5 or -5 to +5 VDC, Differential) Next Generation Module, SMT
	3701N (0-10 VDC) – Through Hole	3701N2 (0-10 VDC) - SMT
	3510N (Pulse Input)	3511N (Pulse Input) – Faster Input Scan

Module	Tricon V9.5.3 System	Tricon V10.2.1 System
	3703EN (Isolated)	Same
	3708EN (ITC)	Same
	3704EN (0-5/0-10 VDC, High Density)	Removed
	3706AN (NITC)	Removed
I/O Modules Analog Output (AO)	3805EN (4-20 mA)	3805HN (4-20 mA) – Supports increased inductive loads
I/O Modules Digital Input (DI)	3501TN 115V AC/DC – Through Hole	3501TN2 115V AC/DC – SMT
	3502EN 48V AC/DC – Through Hole	3502EN2 48V AC/DC – SMT
	3503EN 24V AC/DC – Through Hole	3503EN2 24V AC/DC – SMT
	3504EN 24/48 VDC – Through Hole	Removed
	3505EN 24 VDC – Through Hole	Removed
I/O Modules Digital Output (DO)	3604EN 24 VDC 3624N 24 VDC, Supervised	3625N 24 VDC, Supervised/ Unsupervised Next Generation Module
	3601TN 115 VAC	Same
	3603TN 120 VDC	Same
	3607EN 48 VDC	Same
	3623TN 120 VDC, Supervised	Same
	3636TN (Relay Output)	Same
Remote Extender Modules: **Primary** **Remote**	 4210N (Single Mode Fiber Optic cable) 4211N (Single Mode Fiber Optic cable)	 4200N (Multi Mode Fiber Optic cable) 4201N (Multi Mode Fiber Optic cable)
I/O Module Term Panels	Version 8 Term Panels	Removed
Signal Conditioners	▪ Signal Conditioner (-100 to 100 °C) Pt (7B34-01-1) ▪ Signal Conditioner (0 to 100 °C) Pt (7B34-02-1) ▪ Signal Conditioner (0 to 200 °C) Pt (7B34-03-1) ▪ Signal Conditioner (0 to 600 °C) Pt (7B34-04-1)	Same

Module	Tricon V9.5.3 System	Tricon V10.2.1 System
	Not included	Four additional Signal Conditioners: ▪ Signal Conditioner (0 to 200 °C) Pt (7B34-CUSTOM) ▪ Signal Conditioner (0 to 600 °C) Pt (7B34-CUSTOM) ▪ Signal Conditioner (0 to 100 mV) (7B30-02-1) ▪ Signal Conditioner (0 to 120 °C) Cu (7B14-C-02-1)
Power Supplies:	ASTEC Power Modules	Alternate Vicor Power Modules
120 V	8310N	8310N2
24 VDC	8311N	8311N2
230 VAC		8312N2
Chassis:		
Main	8110N	8110N2
Expansion	8111N	8111N
Remote Expansion	8112N	8112N

1.3.2 Software (See Table "Safety-related Software" in SER)

Module	Tricon V9.5.3 System Software Version	Tricon V10.2.1 System Software Version
TriStation 1131 Developer's Workbench ***(Application Development Software)***	v3.1	v4.1.437
Main Processor Software:		
Application Processor	TSX 5211	ETSX 6198 (Build 92)
I/O Processor	IOC 5212	IOCCOM 6054 (Build 92)
COM Processor	COM 5206	
Communication Module Software:		
TCM	Not Applicable	TCM 6136 (Build 92)
Common V9.5.3 COM	ICM 4930	Not Applicable
EICM	IICX 5276	Not Applicable
NCM	NCMX 5028	Not Applicable
ACM	ACMX 5203	Not Applicable

I/O Module Software	Tricon V9.5.3 System Software Version	Tricon V10.2.1 System Software Version
AI 3721N	Not Applicable	AI 6200 (Build 92)
DO 3625N	Not Applicable	DO 6213 (Build 92)
AI 3701N/N2	AI/NITC 4873	AI/NITC 5661
IAI 3703EN	EIAI/ITC 5491	EIAI/ITC 5916
ITC 3708EN	EIAI/ITC 5491	EIAI/ITC 5916
PI 3510N	PI 4559	Not Applicable
PI 3511N	Not Applicable	PI 5647
AO 3805EN/HN	EAO 5595	EAO 5897
DI 3501TN/TN2 **DI 3502EN /EN2** **DI 3503EN/EN2**	EDI 5490	EDI 5909
DI 3505EN	EDI 5490	Not Applicable
DI 3504EN	HDI 5499	
AI 3704EN	HDI 5499	
DO 3601TN **DO 3607EN**	EDO 5488	EDO 5781
DO 3604EN	EDO 5488	Not Applicable
RO 3636TN	ERO 5497	ERO 5777
DO 3603TN	TSDO 5502	Same
DO 3623TN	TSDO 5502	TSDO2 5940
DO 3624N	TSDO 5502	Not Applicable
Remote Extender Modules	RXM 3310	Same

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1.3.3 Quality Assurance/Procedures Process Changes

Table 2: Summary of Changes to Quality Procedure Manual procedures

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1.3.5 Review of Documents Credited in V9.5.3 SER BTP 7-14 Evaluations

In the SER, the elements of BTP 7-14 (NRC software guidance) were reviewed against documents that were transmitted to the NRC. The NRC ADAMS numbers for these reference documents were also listed in the SER. The V9.5.3 SER identified 11 elements of interest in BTP 7-14:

- Software Management Plan
- Software Development Plan
- Software Quality Assurance Plan
- Software Integration Plan
- Software Installation Plan
- Software Maintenance Plan
- Software Training Plan
- Software Operations Plan
- Software Safety Plan
- Software Verification & Validation Plan
- Software Configuration Management Plan

Several documents were referenced in the SER discussions (sections 4.2.2.1 through 4.2.2.11) in supporting the staff's conclusion that the software development and life cycle planning for the V9.5.3 Tricon PLC system is adequate for software intended for safety-related use in nuclear power plants. Documents identified in the SER included:

- V9.5.3 Software Qualification Report (SQR) (ML003733651)
- Triconex User Documents (ML003702538)
- Triconex Training Manual (ML003702538)
- QAM (Quality Assurance Manual) (ML010610188)
- Applicable TUV Report (ML012700039)

For V10.2.1, a review was performed to identify changes to these referenced V9.5.3 documents (or current equivalent) and to assess any potential impact on the V10.2.1 platform with respect to BTP 7-14 compliance.

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1.3.6 Qualification Process

Overall Qualification Process was as per EPRI 107330 requirements for both Tricon V9.5.3 and Tricon V10.2.1 systems. The following new reports for Tricon V10.2.1 (equivalent to V9.5.3 reports) were developed, reviewed, and released:

- 9600164-545, Rev 3 , Equipment Qualification Summary Report (EQSR)
- 9600164-539, Rev 1, Critical Digital Review (CDR)
- 9600164-535, Rev 1, Software Qualification Report, (SQR)
- 9600164-541, Rev 0, System Description
- 9600164-532, Rev 0, Reliability-Availability Study

Section 4.1.3 discusses the staff's review of the V9.5.3 Tricon environmental testing. For the V10.2.1 Tricon, EQSR sections 4.1 to 4.10 provide detailed discussion of qualification activities. Several of the test suites were changed to address contingencies identified by the NRC in the SER, such as temperature and humidity, and radiation hardness.

Tricon V9.5.3 System	**Tricon V10.2.1 System**
IEEE 323-1983	IEEE 323-2003
Low Humidity, limited due to test equipment	Low Humidity tested to TR-107330 requirements
Radiation qualification by analysis	Radiation qualification by test
EMC testing to TR-102323 **(Please see section 6.1 EMC tests differences between Tricon V9.5.3 and Tricon V10.2.1 Systems for details)**	EMC testing to R.G. 1.180 R1 (Please see section 6.1 EMC tests differences between Tricon V9.5.3 and Tricon V10.2.1 Systems for details)
Seismic envelope – 10G's	Seismic envelope – 14 G's
No electrostatic discharge testing	Electrostatic discharge testing performed to IEC 61000-4-2

1.4 References

The following documents were used as references in the development of this document:

- 9600164-545, Rev 3 (EQ Summary Report)
- 9600164-539, Rev 1 (TRICON V10_2_1 CDR)
- 9600164-535, Rev 1 (Software Qualification Report)
- 9600164-541, Rev 0 (System Description)
- 9600164-532, Rev 0 (Reliability-Availability Study)
- 9100041-001, rev 17, Triconex Nuclear Qualified Equipment List (Tricon v9 NQEL)
- 9100150-001, rev 6, Tricon v10 Nuclear Qualified Equipment List (Tricon v10 NQEL)

2.0 Main Processor Differences

The following sections provide detailed information about the Main Processor (MP) hardware and software differences between the Tricon V9.5.3 and the Tricon V10.2.1.

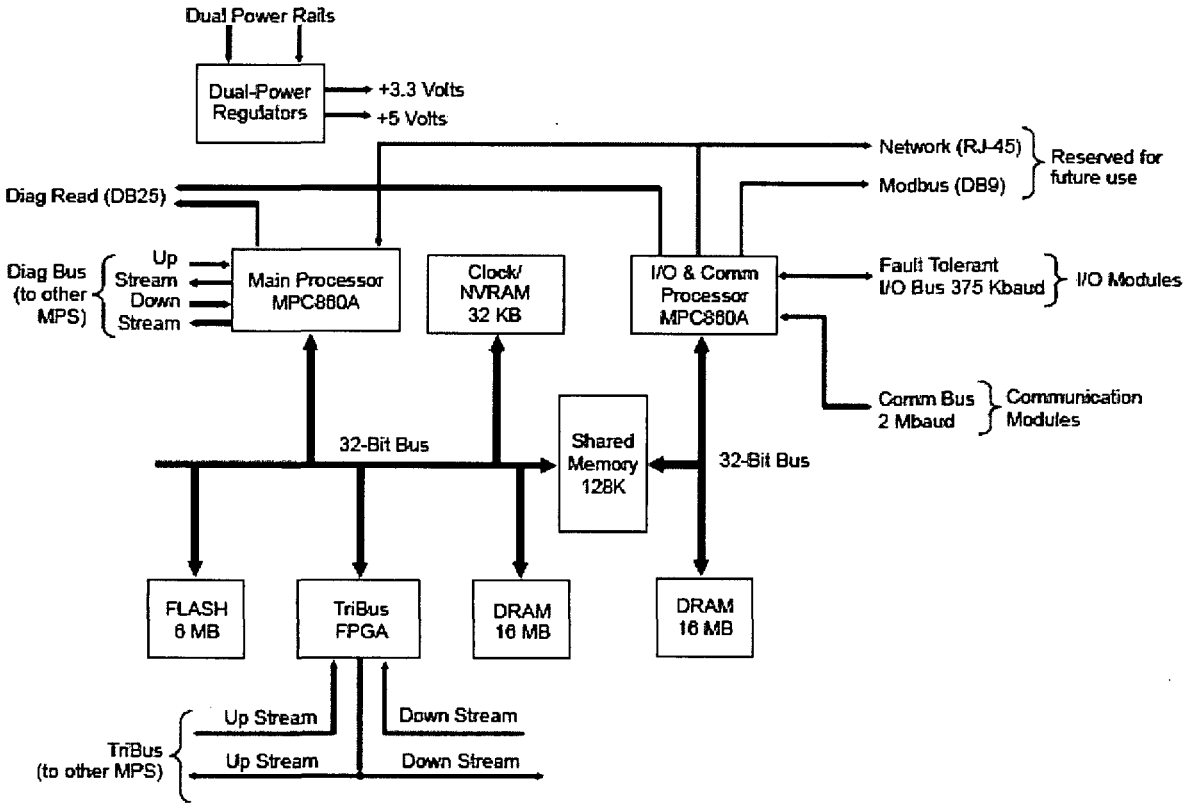
2.1 Main Processor Hardware Differences

SER Section 2.1.2 discusses the hardware in the Main Processor for the V9.5.3 Tricon. Since the time the SER was issued, the Main Processor has been updated. The EQSR for V10.2.1 Tricon describes in section 3.1.6 the updated Main Processor. The CDR describes in detail the upgrades to the Main Processor in sections 3.1.1 thru 3.1.5. The following table, based upon Table 3-1 in the CDR, details the hardware differences between the Tricon V9.5.3 Model 3006N Main Processor and the Tricon V10.2.1 Model 3008N Main Processor:

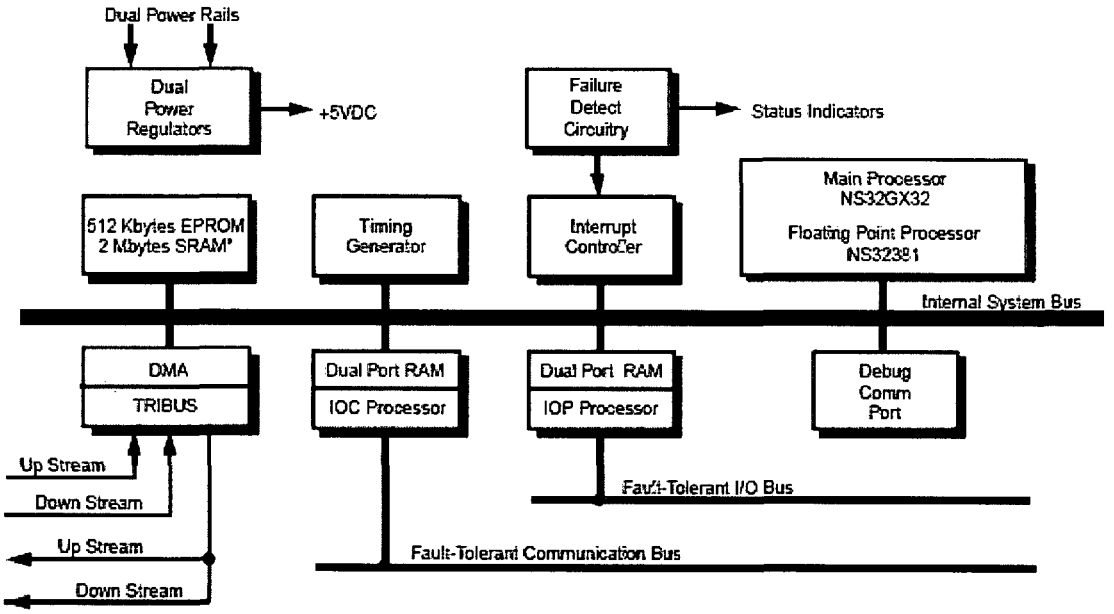
Tricon V9.5.3 Model 3006N MP	**Tricon V10.2.1 Model 3008N MP**
Three microprocessors for: ▪ **Application** (1) ▪ **Input/Output Modules** (2) ▪ **Communication Modules** (3)	Two microprocessors for: ▪ Application (1) ▪ Input, Output, and Communications Modules (2)
Hardware floating point processor	Embedded floating point software
Components are through-hole. Single-printed circuit board inside module is **covered in components.**	Components use Surface Mount Technology (SMT). Most of base-printed circuit board inside the module is empty, with limited circuits, connectors, and power conditioning. Most of MP functionality is on attached daughter card.
Application microprocessor is 25 MHz 32-bit National Semiconductor 32GX32 (now **obsolete).**	Application microprocessor is 50 MHz 32-bit Freescale Semiconductor (was Motorola) MPC860EN microcontroller.
MP TSX program stored in 512 kilobyte (kb) **Programmable Read-Only Memory (PROM).**	MP ETSX program stored in 2 megabyte (MB) flash memory.
Firmware upgrade by PROM replacement.	Firmware upgrade via download through Ethernet port on MP front panel.
Control Program and Sequence of Events data stored in 2 MB **battery-backed, static random access memory (SRAM).**	Control Program and Sequence of Events data stored in 16 MB dynamic random access memory (DRAM) while running. Control Program is backed up in 4 MB flash memory. Any information that should be preserved during a power failure (such as control program retentive data and disabled point settings) is stored in 32 KB battery-backed, non-volatile random access memory (NVRAM).
MP watchdog timer is **set at 2.4 second timeout.**	MP watchdog timer is set at 0.512 second timeout.
TriClock used for MP rendezvous.	TriTime for MP rendezvous.

Tribus used for voting, 4 Megabits (Mb)**/second**	Tribus used for voting, 25 Mb/second.
Tricon **node address set in configuration**.	Tricon node address set on MP front panel and in application software configuration.
TSX Debug port on MP front panel.	ETSX and IOCCOM Debug ports on MP front panel.
Input/Output Module Controller (IOC) is NXP (was Phillips Semiconductor) 80C31, programmed in Assembly language.	Input, Output, and Communication Modules Controller (IOCCOM) is 50 MHz 32-bit Freescale Semiconductor MPC860EN.
Communication Module Controller (COM) is an Intel 80C152.	
IOC stored in 64 kilobyte PROM.	Combined IOCCOM program stored in 2 MB flash memory.
COM stored in 64 kilobyte PROM.	

The following figure illustrates the Tricon V10.2.1 Model 3008N Main Processor block diagram:



The following figure illustrates the Tricon V9.5.3 Model 3006N Main Processor block diagram:



2.2 Main Processor Software Differences

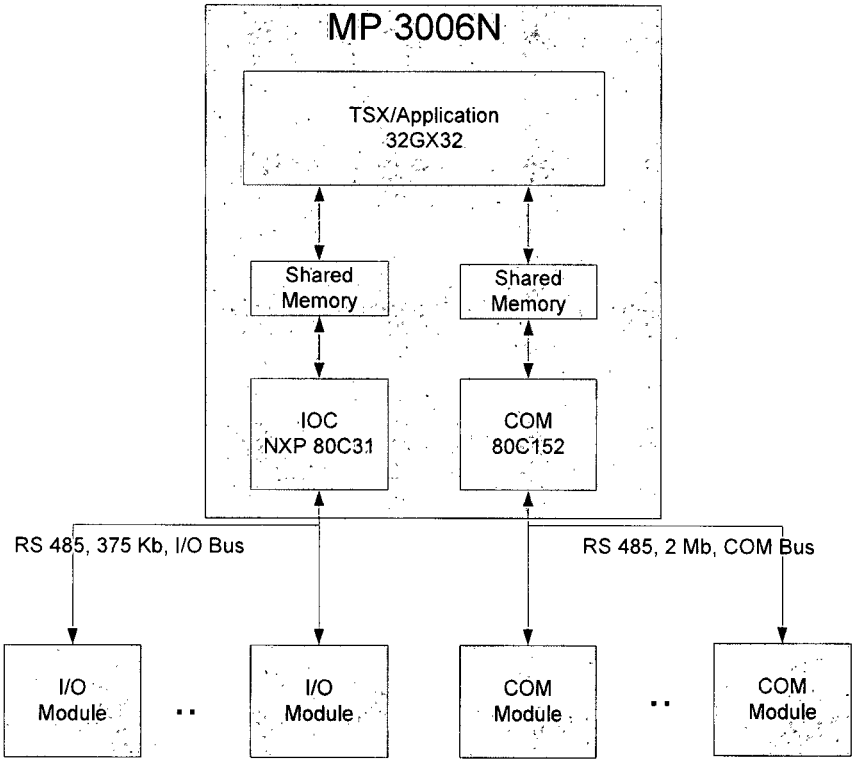
SER Section 2.2.1 discusses the software in the Main Processor for the V9.5.3 Tricon. When the architecture of the Main Processor changed, as described above, the software was updated. The EQSR for V10.2.1 Tricon describes in section 3.2.1 the updated software for the Main Processor. The CDR describes in detail the upgrades to the Main Processor software in sections 3.1.6. The following sections detail the software differences between the Tricon V9.5.3 Model 3006N Main Processor and the Tricon V10.2.1 Model 3008N Main Processor.

2.2.1 Tricon V9.5.3 Model 3006N MP Software

The Tricon V9.5.3 Model 3006N MP has three separate sets of software (firmware) associated with three microprocessors:

- **Triconex System Executive (TSX)** – Runs on the application processor (NS32GX32). The TSX executes the application (also known as the *control program*) on a per-scan basis.
- **Input/Output Control (IOC)** – Runs on the I/O processor (NXP 80C31). The IOC manages the inputs/outputs to and from the I/O modules. The IOC interfaces to the TSX via shared memory, and interfaces to the I/O modules via an RS 485 I/O bus.
- **Communication Modules Control (COM)** – Runs on the COM processor (Intel 80C152). The COM manages the incoming and outgoing messages to and from the communication modules. The COM interfaces to the TSX via shared memory, and interfaces to the communication modules via an RS 485 I/O bus.

The following figure illustrates the hardware and software relationships for the Model 3006N MP:



MP 3006N Hardware/Software Block Diagram
Tricon 9.5.x System

2.2.2 Tricon V10.2.1 Model 3008N MP Software

The Tricon V10.2.1 Model 3008N MP has two separate sets of software (firmware) associated with two microprocessors:

- **Enhanced Triconex System Executive (ETSX)** – Runs on the application processor (MPC 860A). The ETSX executes the application (also known as the *control program*) on a per-scan basis. The code base for the ETSX code was taken from TSX and LSX (the Laguna System Executive). The following figure illustrates the ancestry of ETSX (see section 3.1.6 of the CDR for details on the software history of the 3008N MP):

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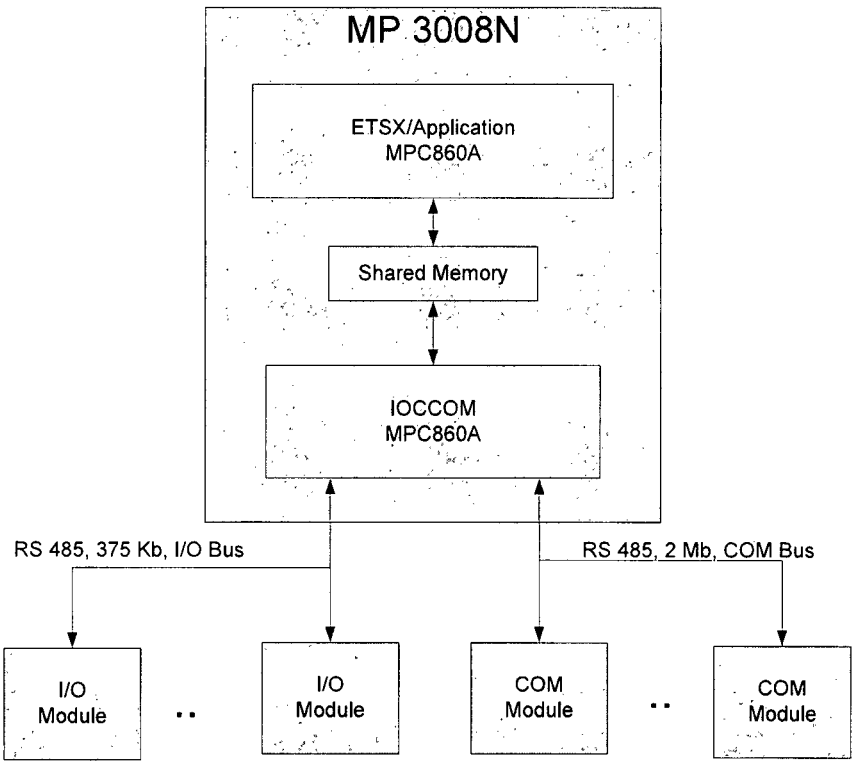
The IOCCOM manages the inputs/outputs to and from the I/O modules, and the incoming/outgoing messages to and from the communication modules. The IOCCOM interfaces to the ETSX via shared memory, interfaces to the I/O modules via an RS 485 I/O bus, and interfaces to the communication modules via a separate RS 485 COM bus. There are dedicated communication channels between the MP and the TCM such that communication errors or external network events (such as data storms) will not affect the safety function.

The IOCCOM software uses no interrupts except for the watchdog. The I/O bus handling is always the highest priority. The COMBUS functions are performed while the I/O bus is waiting for a response.

The following figure illustrates the hardware and software relationships for the Model 3008N MP (see section 3.1.6 of the CDR for additional details on the IOCCOM software):



MP 3008N Hardware/Software Block Diagram
Tricon 9.6 and later Systems

2.2.3 Comparison of TSX and ETSX

The following table compares the Tricon V9.5.3 Model 3006N MP software (TSX) with the Tricon V10.2.1 Model 3008N software (ETSX):

Item	Tricon V9.5.3 Model 3006N MP (TSX)	Tricon V10.2.1 Model 3008N MP (ETSX)
Architecture	Basis for ETSX	The basis for ETSX is TSX. TSX was migrated from the 32GX32 processor to the MPC860A processor, and enhanced to support new communication modules and I/O modules. This is why ETSX architecture is very similar to TSX architecture.
Application Programming Model & Development Workstation	TriStation 1131, v3.1	TriStation 1131, v4.1.437
Inter-Processor Interface	Tribus	Tribus
Shared Memory Interface	IOC (64K) COM (64K)	IOCCOM (128K)
Interface to I/O Modules	4-Wire RS-485	4-Wire RS-485
Interface to COM Modules	2-Wire RS-485	2-Wire RS-485
I/O Bus Protocol	375K Baud async	375K Baud async
COM Bus Protocol	2 MB HDLC	2 MB HDLC
External Host Interface Protocols	Modbus, TSAA	Modbus, TSAA

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a, b

Item	Tricon V9.5.3 Model 3006N MP (IOC and COM)	Tricon V10.2.1 Model 3008N MP (IOCCOM)
Shared Memory Interface	IOC (64K) COM (64K)	IOCCOM (128K)
Interface to I/O Modules	4-Wire R-485	4-Wire RS-485
Interface to COM Modules	2-Wire RS-485	2-Wire RS-485
I/O Bus Protocol	375K Baud async	375K Baud async
COM Bus Protocol	2 MB HDLC	2 MB HDLC

a, b

2.2.4.1 Differences between IOC / COM and IOCCOM Subsystems

The following table describes the differences between the major subsystems of the Tricon V9.5.3 Model 3006N MP software (IOC and COM) and the Tricon V10.2.1 Model 3008N software (IOCCOM):

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3.0 I/O Modules

The following sections provide detailed information about the I/O Module hardware and software differences between the Tricon V9.5.3 and the Tricon V10.2.1.

3.1 I/O Module Hardware

Section 2.1.3 of the SER discusses the I/O module hardware for V9.5.3 Tricon. Since the time of issue of the SER, the Tricon I/O has been upgraded. In some cases the upgrades were improvements to existing boards (e.g., PI 3511N), in other cases the changes were more significant (e.g., conversion to surface mount technology). EQSR section 3.1.7 discusses V10.2.1 I/O module hardware, and section 3.3 lists the specific I/O modules that went through qualification testing for V10.2.1. It should be noted that the CDR discusses primarily the next-generation I/O (see section 3.2). The following sections detail the hardware differences between I/O Modules in the Tricon V9.5.3 and the Tricon V10.2.1.

3.1.1 Analog Input (AI) Modules

The following AI modules are the **same** for the Tricon V9.5.3 and Tricon V10.2.1:

- *3703EN – Isolated AI module (IAI)*
- *3708EN – Isolated Thermo Couple (ITC)*

The following modules from the Tricon V9.5.3 are **not included** in the Tricon V10.2.1:

- *3700AN – AI (0-5 VDC)*
- *3704EN – AI (0-5/0-10 VDC, High Density)*
- *3706AN – Non-isolated Thermo Couple (NITC)*
- *3510N – Pulse Input*

The following through-hole technology modules from the Tricon V9.5.3 have been **converted** to form-, fit-, and function-compatible Surface Mount Technology (SMT) modules, and qualified for the Tricon V10.2.1:

- *3701N2 – AI (0-10 VDC)*
  - The only changes required for conversion from the through-hole module to SMT module are the implementation changes:
    - A new PCB layout for the SMT module.
    - Use of SMT parts in place of through-hole parts.
  - This SMT module was reviewed and verified by TÜV (independent third-party).

The following modules (not in the Tricon V9.5.3) have been **added** to the Tricon V10.2.1:

- *3721N – AI (0-5 or -5 to +5 VDC, Differential); Next Generation Module, SMT*
    - This is a Next Generation AI module that uses the same basic TMR (Triple Modular Redundant) architecture of the previous I/O modules. The interface to the I/O bus and I/O protocol for communication to the MP is the same as previous I/O modules.
    - Each channel (leg) of the 3721N module has an ATMEL AT91R40008 ARM microcontroller and a Xilinx Spartan IIE 1.8V Field Programmable Gate Array (FPGA). Each channel has a separate 2 MB flash memory. The microprocessor's 16-bit bus connects to the FPGA and flash memory.
    - The 3721N AI module provides significant advantages over the previous AI modules for the Tricon V9.5.3:
        - A 10 msec scan rate for all the field inputs, compared to the 50 msec scan rate for all the field inputs of previous AI modules (such as the 3700AN).
        - Can be configured for unipolar input (0 to 5 VDC) or bipolar input (-5 to +5 VDC).
        - 14-bit resolution, versus the 12-bit resolution of previous AI modules.
    - The module performs the same types of checks and verifications across channels as the Tricon V9.5.3 AI modules.
    - This module replaces the following Tricon V9.5.3 modules:
        - 3700AN – AI (0-5 VDC)
        - 3704EN – AI (0-5/0-10 VDC, High Density)
    - CDR sections 3.2 and 3.2.1 discuss in detail the next generation I/O hardware. Also, see section 3.2.4, "Analog Input Customization"

- *3511N - Pulse Input*
    - The Model 3511N Pulse Input module features a faster input scan, providing a faster speed measurement capability for the V10.2.1 Tricon.
        - The worst case speed measurement update rate of the Model 3510 PI is 50 msec.
        - The PI 3511N measurement update rate is twice as fast as the 3510: 12.5 msec typical, 25 msec worst case.
    - The Model 3511N PI module is based upon the existing Model 3510N PI module hardware/software platform, with minor modifications. Specially, the internal reference frequency is changed from 1 MHz to 2 MHz, and the firmware

calculations scaled appropriately. Other than an improved update rate, none of the other published specifications are affected.

- This module replaces the Tricon V9.5.3 3510N module.

3.1.2 Analog Output (AO) Modules

The Tricon V9.5.3 *Model 3805EN (4-20 mA) Analog Output* module was modified to resolve the problem with high inductive loads connected to the output points during the periodic board switch. The problem details are presented below.

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Both the AO modules (Model 3805EN and Model 3805HN) are form-, fit-, and function-compatible.

The Model 3805H module was included in the Tricon V10.2.1 qualification.

3.1.3 Digital Input (DI) Modules

The following through-hole technology modules from the Tricon v9.5.3 have been **converted** to form-, fit-, and function-compatible Surface Mount Technology (SMT) modules, and qualified for the Tricon V10.2.1:

- *Model 3501TN DI (115V AC/DC)* through-hole module converted to *Model 3501TN2 DI (115V AC/DC)* SMT module.
- *Model 3502EN DI (48V AC/DC)* through-hole module converted to *Model 3502EN2 DI (48V AC/DC)* SMT module.
- *Model 3503EN DI (24V AC/DC)* through-hole module converted to *Model 3503EN2 DI (24V AC/DC)* SMT module.

The only changes required for conversion from the through-hole module to SMT module are the implementation changes:

- A new PCB layout for the SMT module.
- Use of SMT parts in place of through-hole parts.

The SMT modules were reviewed and verified by TÜV (independent third-party).

The following modules from the Tricon V9.5.3 are **not included** in the Tricon V10.2.1:

- *3504EN DI (24/48 VDC)*
- *3505EN DI (24 VDC)*

3.1.4 Digital Output (DO) Modules

The following modules from the Tricon V9.5.3 are **not included** in the Tricon V10.2.1:

- *3604EN DO 24 VDC*
- *3624N DO 24 VDC, Supervised*

The following DO modules are the **same** for the Tricon V9.5.3 and Tricon V10.2.1:

- *3601TN DO 115 VAC*
- *3603TN DO 120 VDC*
- *3607EN DO 48 VDC*
- *3623TN DO 120 VDC, Supervised*
- *3636TN RO (Relay Output)*

The following module (not in the Tricon V9.5.3) has been **added** to the Tricon V10.2.1:

- *3625N DO (24 VDC, Supervised/Unsupervised), Next Generation SMT Module*
  - This is a Next Generation DO module that uses the same basic TMR (Triple Modular Redundant) architecture of the previous I/O modules.
  - The interface to the I/O bus and I/O protocol for communication to the MP is the same as previous I/O modules.
  - Each channel (leg) of the Model 3625N module has an ATMEL AT91R40008 ARM microcontroller and a Xilinx Spartan IIE 1.8V Field Programmable Gate Array (FPGA). Each channel has a separate 2 MB flash memory. The microprocessor's 16-bit bus connects to the FPGA and flash memory.
  - The Model 3625N DO module provides significant advantages over the previous Tricon V9.5.3 DO modules:
    - 32 output points, compared to 16 points for the old modules
    - Can be configured as supervised or unsupervised
  - This module replaces the following Tricon V9.5.3 modules:
    - *3604EN DO 24 VDC*
    - *3624N DO 24 VDC, Supervised*
  - CDR sections 3.2 and 3.2.1 discuss in detail the next generation I/O hardware. Also, see section 3.2.3, "Digital Output Customization"

3.1.5 Remote Extender Modules

Section 2.1.1.3 of the SER discusses Remote Extender modules for V9.5.3. See EQSR section 3.3 for a list of components that went through qualification testing for V10.2.1. The following Remote Extender modules from the Tricon V9.5.3 are **not included** in the Tricon V10.2.1:

- *4210N (Single Mode Fiber Optic cable) Primary Remote Extender module*
- *4211N (Single Mode Fiber Optic cable) Secondary Remote Extender module*

The following Remote Extender modules are **included** in the Tricon V10.2.1:

- *4200N (Multi Mode Fiber Optic cable) Primary Remote Extender module*
- *4201N (Multi Mode Fiber Optic cable) Secondary Remote Extender module*

3.1.6 I/O Module Term Panels

All Tricon v8 I/O module term panels were removed from the Tricon V10.2.1.

3.1.7 Signal Conditioners

The following Signal Conditioners are the **same** for the Tricon V9.5.3 and Tricon V10.2.1:

- Signal Conditioner (-100 to 100 °C) Pt (7B34-01-1)
- Signal Conditioner (0 to 100 °C) Pt (7B34-02-1)
- Signal Conditioner (0 to 200 °C) Pt (7B34-03-1)
- Signal Conditioner (0 to 600 °C) Pt (7B34-04-1)

The following Signal Conditioners have been **added** to the Tricon V10.2.1:

- Signal Conditioner (0 to 200 °C) Pt (7B34-CUSTOM)
- Signal Conditioner (0 to 600 °C) Pt (7B34-CUSTOM)
- Signal Conditioner (0 to 100 mV) (7B30-02-1)
- Signal Conditioner (0 to 120 °C) Cu (7B14-C-02-1)

3.2 I/O Module Software

SER section 2.2.1.2 discusses I/O module software for each module reviewed for V9.5.3. Since that time, the software for the I/O modules has been upgraded. EQSR section 3.1.7 discusses V10.2.1 I/O module software, and section 3.3 lists the specific I/O modules that went through qualification testing for V10.2.1. It should be noted that the CDR discusses primarily the next-generation I/O (see section 3.2). The following sections detail the software differences between I/O Modules in the Tricon V9.5.3 and the Tricon V10.2.1. Note that the tables below are based on the table in SER Section 2.2.1, "Safety-related Software," but with the addition of a column containing V10.2.1 software versions for comparison.

3.2.1 Analog Input (AI) Modules

The software for the AI modules common to both systems is the same.

AI Module	Tricon V9.5.3 Software version	Tricon V10.2.1 Software version
AI 3701N/N2	AI/NITC 4873	AI/NITC 5661
IAI 3703EN	EIAI/ITC 5491	EIAI/ITC 5916
ITC 3708EN	EIAI/ITC 5491	EIAI/ITC 5916
PI 3510N	PI 4559	Not Applicable
PI 3511N	Not Applicable	PI 5647
AI 3721N[1]	Not Applicable	AI 6200 (Build 92)

AI 3721N is a next-generation I/O module that not only provides significant enhancements in functionality, but also improve maintainability because it is built upon a common software "core". The software provides improved functionality, with common routines for actions performed by all the new I/O modules.

The software uses an FPGA to perform all interactions with the hardware. As a result, the microprocessor code does not have to deal with timing issues or other hardware issues, as these are hidden from the software in the FPGA logic, thus simplifying the software in each module. Rather, the microprocessor is presented with a common set of memory-mapped registers which provide a common interface to the inputs, outputs, communication channels, and the module itself. Both the HDLC communications protocol and the communications between the microprocessor channels on the module are handled by the FPGA, eliminating microprocessor software support requirements for both.

The core software consists of five tasks. The highest priority task is the Periodic Timer Interrupt Task. The MP Communication Interrupt Task is the second highest priority. The External Watchdog Interrupt Task is the third highest priority. The Foreground Interrupt Task is the fourth highest priority task, and the Background Task is the fifth and lowest priority task.

Each channel performs diagnostics on startup, which must complete successfully before the module channel is allowed to become operational. After startup, run-time diagnostics are performed periodically, normally in the background or foreground loop.

a, b

Module-specific software components have a defined interface. The interface between the core and the module-specific software components is specified in a Unified Modeling Language (UML) model developed using ARTiSAN tools. The core software supports data types for discrete, integer, and real data, and data quality for each point. The core software supports up to 64 points per module.

The software that coordinates messages to and from the MP ensures that the module does not respond to messages that are not addressed to it, using the chassis and slot data read from the Tricon backplane. The software checks for message corruption using a 16-bit CRC. Corrupt messages are ignored.

Using the timers, the software synchronizes with the other two channels, to ensure that data sampling is coordinated, which minimizes sampling-induced data variances. Synchronization is designed to ensure that failures in one or two channels do not result in loss of data.

Several different types of diagnostics are performed. As an example, the watchdog timer diagnostic coordinates with the other two channels, and only then does that channel allow its watchdog timer to time out. The module microprocessors verify the correct operation of outputs on an output module, and then the microprocessor restarts the process of strobing the watchdog. Watchdog timer strobes occur at least every 4096 microseconds, no more often than every 1024 microseconds, and avoiding the watchdog guard registers. Less frequent tests include walking data patterns through the RAM, verifying the RAM address lines, verifying the CRCs on flash memory blocks, verifying the FPGA version, and verifying the FPGA configuration data against the configuration data stored in flash memory.

3.2.2 Analog Output (AO) Modules

The software for the Model 3805EN AO module (Tricon V9.5.3) has gone through upgrades for incorporation into the Model 3805HN (Tricon V10.2.1). The version number for V10.2.1 of this software is EAO 5897.

3.2.3 Digital Input (DI) Modules

DI Module	Tricon V9.5.3 Software Version	Tricon V10.2.1 Software Version
DI 3501TN/TN2 **DI 3502EN /EN2** **DI 3503EN/EN2**	EDI 5490	EDI 5909
DI 3505EN	EDI 5490	Not Applicable
DI 3504EN **AI 3704EN**	HDI 5499	

3.2.4 Digital Output (DO) Modules

DO Module	Tricon V9.5.3 Software Version	Tricon V10.2.1 Software Version
DO 3625N[2]	Not Applicable	DO 6255 (Build 92)
DO 3601TN **DO 3607EN**	EDO 5488	EDO 5781
DO 3604EN	EDO 5488	Not Applicable
RO 3636TN	ERO 55497	ERO 5777
DO 3603TN	TSDO 5502	Same
DO 3623TN	TSDO 5502	TSDO2 5940
DO 3624N	TSDO 5502	Not Applicable

The software provides improved functionality, with common routines for actions performed by all the new I/O modules. Please refer to section 3.2.1 (3721N AI module) for a detailed description of next-generation I/O.

3.2.5 Remote Extender Modules

The software for the remote extender modules in both Tricon V9.5.3 and Tricon V10.2.1 is the same. The software version number is RXM 3310.

4.0 Communication Modules

Sections 2.1.4 and 2.2.1.3 of the SER discuss the communications modules hardware and software, respectively, for Tricon V9.5.3. Significant changes were made to the communications module for Tricon V10.2.1, as discussed in CDR section 3.3. The following sections provide detailed information about the communication processor hardware and software differences between the Tricon V9.5.3 and the Tricon V10.2.1. Extensive discussion on the results of an independent review of the Tricon V10.2.1 communications module is provided in CDR Appendices A and B.

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4.1 Communication Module Hardware

As mentioned earlier, the Tricon V9.5.3 has three communication modules:

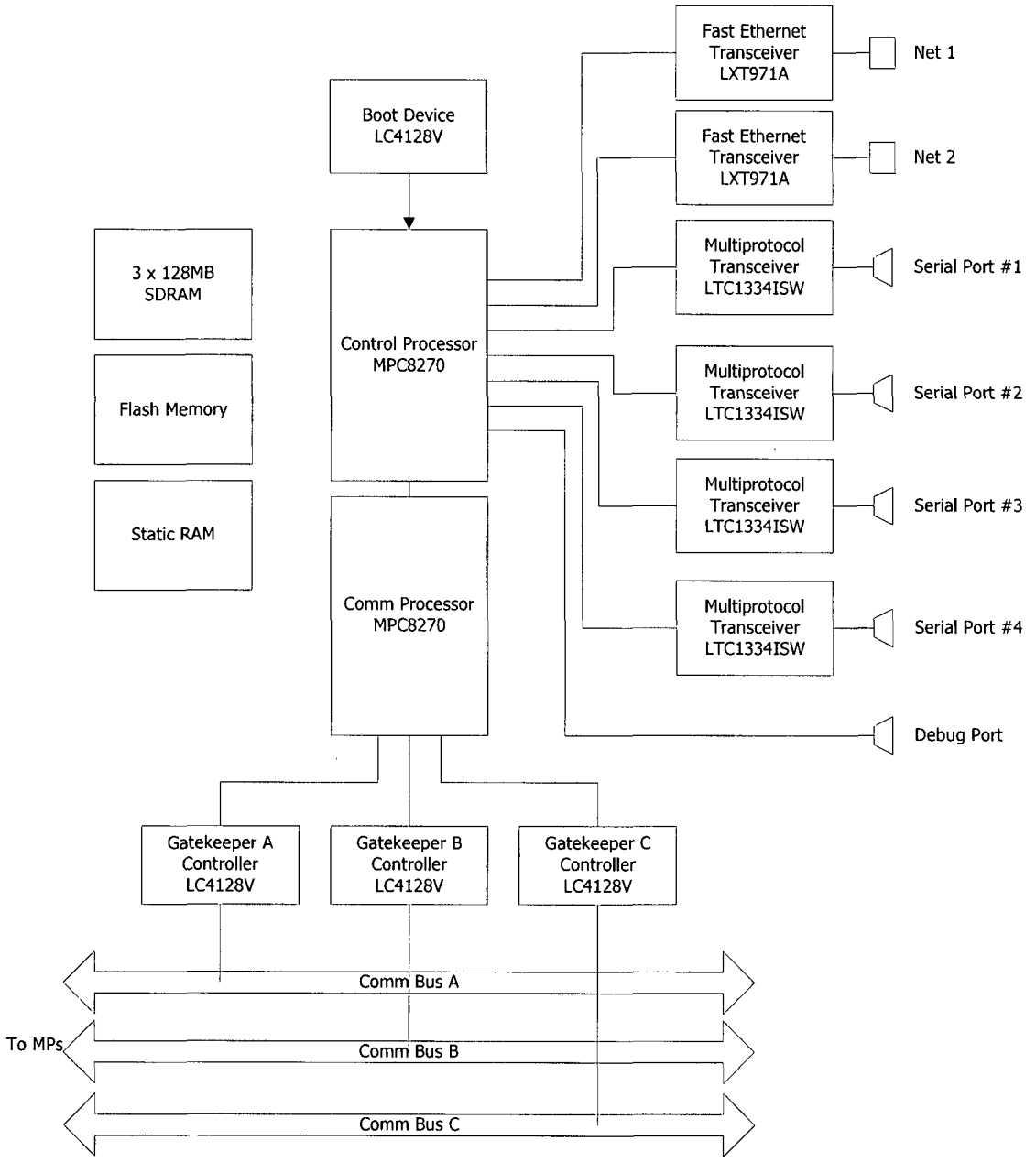
- 4119AN (EICM)
- 4329N (NCM)
- 4609N (ACM)

The new 4352AN (TCM) Fiber Optic module qualified in Tricon V10.2.1 replaces the functionality of the above three communication modules.

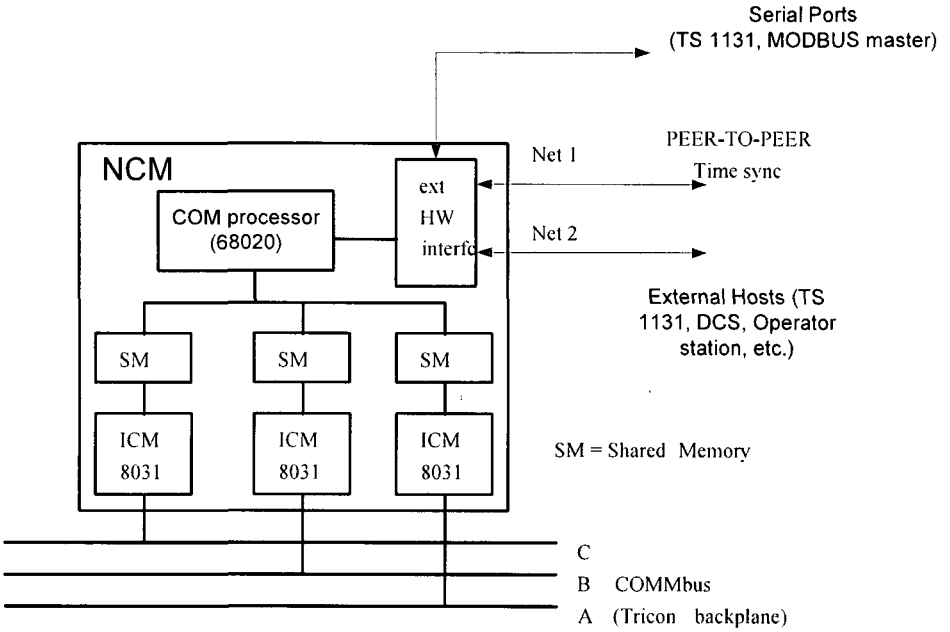
Module	Tricon V9.5.3	Tricon V10.2.1
Communication Module	Three modules: ▪ 4119AN (EICM) ▪ 4329N (NCM) ▪ 4609N (ACM)	One module: ▪ 4352AN (TCM) Fiber Optic

From the interface point of view, the TCM architecture is the same as the other communication modules. It uses the same RS-485 COM bus (triplicated), and the same COM protocol to communicate with the MPs. It communicates to external hosts (such as the TriStation 1131 workstation, MODBUS Master, DCS, other Tricon or Trident systems, etc.) using the 802.3 fiber optic interface or the serial interface. The new TCM uses the MPC8270 microprocessor and flash memory for software storage, while the previous communication modules used the 68020, 8031, and 8086 family of microprocessors and PROMs for software storage.

The TCM 4352AN and NCM 4329N basic block diagrams are provided on the following pages for comparison purposes:



TCM 4352AN Block Diagram



NCM 4329N Block Diagram

The TCM provides communication between the Tricon and the external world using any of the supported message protocols. The physical interface to the external world is comprised of the following ports:

- Two network ports designated NET 1 and NET 2. On the Model 4352AN TCM, these are fiber-optic ports. These are general-purpose Ethernet connections that can be used for printing, SNTP or GPS time synchronization, application-driven peer-to-peer or master-slave connections, Modbus, TSAA communication, or TriStation configuration.
- Four serial ports, which support Modbus, GPS time synchronization, or TriStation configuration. The serial ports may not be used with TriStation for nuclear applications.
- A debug port, intended solely for troubleshooting by the manufacturer, which interfaces with the control processor.
- The TCM internal physical interface to other Tricon components includes the following:
    - A communication bus that passes information between the TCM and the MPs. The interface is triplicated, and the TCM connects through the backplane to three separate, redundant bus channels, each associated with a single MP. Each connection passes through dedicated 'gatekeeper' circuitry. Before processing, the MPs vote to verify consistency of the received message, using the Tribus connections between the MPs.
    - Power input from the chassis backplane power rails.

- The internals of the TCM include the following:
    - Two programmable MPC8270 controllers. These function as a control processor, which interfaces with the external ports, and a communication processor, which interfaces with the Tricon Communication Bus channels. The communication processor is configured in slave mode; for example, the core is disabled and provides peripherals to the control processor.
    - Three programmable LC4128V chips that each function as a "gatekeeper" controller for one of the Tricon Communication Bus channels.
    - Two LXT971A fast Ethernet transceivers that support network ports NET 1 and NET 2.
    - Three LTC1334ISW multi-protocol transceivers that support Serial Ports 1 through 4.
    - Three SDRAM, two flash memory, and one static RAM integrated circuits.

In addition to these components, the TCM hardware includes external watchdog timer circuitry.

4.2 Communication Module Software

The TCM 4352AN uses VxWorks real-time OS as a base software and associated hardware support package, compared to VRTX real-time OS and associated hardware support package for the Tricon V9.5.3 communication modules (EICM 4119AN, NCM 4329N, ACM 4609N). All the communication module software supports the following application-level protocols:

- TriStation Serial
- TriStation Network
- MODBUS Serial
- Peer-to-Peer
- Tricon System Application Access (TSAA)
- Network Printer
- Time Synchronization
- Simple Network Time Protocol (SNTP)

The code for the above application-level protocols from the Tricon V9.5.3 communication modules was ported with minor changes (for example, OS services calls) to the TCM module.

In addition, the TCM supports the following two protocols:

- MODBUS TCP
- OPC

Checks on the validity of the data between the TCM and the Tricon safety core (MPs and I/O subsystem) are implemented on the MP, which discards any malformed data and votes on any messages (which are sent to each MP identically) over the Tribus prior to processing. Loss of the entire TCM subsystem does not affect the operation of the safety core (MPs and I/O subsystem).

The following table provides a comparison of the communication module software for the Tricon V9.5.3 and Tricon V10.2.1:

Module	Tricon V9.5.3	Tricon V10.2.1
4609N (ACM)	VRTX32 & TNX Real Time OS Software version = ICM 4930, ACMX 5203	Not Applicable
Protocols	TCP (UDP)/IP	TCP (UDP)/IP
	TriStation Serial	TriStation Serial
	TriStation Network	TriStation Network
	MODBUS Serial	MODBUS serial
	-	MODBUS TCP
	-	OPC
	Peer-to-Peer	Peer-to-Peer
	Tricon System Application Access (TSAA)	Tricon System Application Access (TSAA)
	Network Printer	Network Printer
	Time Synchronization	Time Synchronization
	SNTP (Simple Network Time Protocol)	SNTP (Simple Network Time Protocol)

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5.0 TriStation 1131 Software

Section 2.2.3 of the SER discusses the TriStation 1131 software V3.1. Section 4.2.3 of the SER provides the staff's conclusion that the TriStation 1131 V3.1 software is acceptable to produce software that is intended for safety-related use in nuclear power plants. Since the SER was issued, TriStation 1131 software has been modified for maintenance as well as functional improvement. The current revision level is V4.1.437. Section 4.5.4 of the CDR describes the evolution of TriStation 1131 software. The major changes in TriStation 1131 V4.1.437 (Tricon V10.2.1) from TriStation 1131 V3.1 (Tricon V9.5.3) are:

- Automatic upgrade of projects (application/control program) created with the previous versions of TriStation 1131 (v2.x, v3.x, or v4.0) to TriStation 1131 v4.1
- Support for the new I/O modules (3625N DO, 3721N AI, 3807 BPAO) and new communication modules (TCM models)
- New code generator, assembler, and linker for Model 3008N Main Processor
- API interface for automation of application development and testing
- Emulator enhancements for application testing in offline mode
- Bug fixes

The following table summarizes the changes from one version to the next:

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6.0 Appendices

6.1 EMC Test differences between Tricon V9.5.3 and Tricon V10.2.1 systems

Version 9			Version 10		
Test Type	**Test Method**	**Frequency Range**		**Test Method**	**Frequency Range**
Conducted Emissions	CE101	30 Hz to 50 kHz	Conducted Emissions	CE101	30 Hz to 10 kHz
Conducted Emissions	CE102	50 kHz to 400 MHz	Conducted Emissions	CE102	10 kHz to 2 MHz
Radiated Emissions, Magnetic Field	RE101	30 Hz to 100 kHz	Radiated Emissions, Magnetic Field	RE101	30 Hz to 100 kHz
Radiated Emissions, Electric Field	RE102	10 kHz to 1 GHz	Radiated Emissions, Electric Field	RE102	2 MHz to 1 GHz
Conducted Susceptibility, Audio Frequency	CS101	30 Hz to 50 kHz	Conducted Susceptibility, Common-Mode Disturbances	IEC Standard 61000-4-16	15 Hz to 150 kHz
Conducted Susceptibility , High Frequency	CS114	50 kHz to 400 MHz	Conducted Susceptibility, Harmonics and Interharmonics	IEC Standard 61000-4-13	16 Hz to 2.4 kHz
			Conducted Susceptibility, Radio Frequency	IEC Standard 61000-4-6	150 kHz to 80 MHz
Radiated Susceptibility, Magnetic Field	RS101	30 Hz to 100 kHz	Radiated Susceptibility, Power Line Frequency	IEC Standard 61000-4-8	60 Hz
Radiated Susceptibility, Electric Field	RS103	10 kHz to 1 GHz	Radiated Susceptibility, Damped Oscillatory Magnetic Field, Helmholtz Coil Exposure	IEC Standard 61000-4-10	100 kHz and 1 MHz
			Radiated Susceptibility, High Frequency	IEC Standard 61000-4-3	26 MHz to 1 GHz

Version 9			Version 10		
			Radiated Susceptibility, Pulsed Magnetic Field, Helmholtz Coil Exposure	IEC Standard 61000-4-9	----
Conducted Susceptibility, EFT/Burst	IEC 801-4	2.5 to 5 kHz, 3 Hz Burst Rep. Rate	EFT	IEC Standard 61000-4-4	Power Leads, Level 3, Test Voltage Level: 2 kV max. Signal Leads, Level 3 Test Voltage Level: 1 kV max.
Surge Withstand	IEEE C62.41 IEC 801-5 IEC 801-5	Ring Wave Test, 3.0 kV Comb. Wave Test, 3.0 kV Ring Wave Test, 3.0 kV and 1.0 kV	Surge Withstand	IEC Standard 61000-4-12 61000-4-5	Ring Wave Test, 0.5, 1.0, and 2.0 kV Ring Wave Test, 0.5, 1.0, and 2.0 kV

6.2 V&V Summary Report Tricon V9.6 – Tricon V10.2.1 Releases

This Appendix provides a summary report of all V&V activity for Major Revisions, and Maintenance releases since the Tricon V9.6 release. Since Tricon V9.5.3, several maintenance releases have been processed and added to the V9 Nuclear Qualified Equipment List (NQEL), specifically V9.5.6, V9.5.7, V9.51.1, V9.52, and V9.52.1. These V9.5.x upgrades were processed in accordance with Triconex Appendix B QA procedures and reflect the same V9 platform architecture depicted in the V9 SER. Applicable specifications, V&V records, and qualification upgrade evaluations are on file for these V9 upgrades.

Notwithstanding the "V9" designation, the Tricon V9.6 marked the beginning of the new "V10" architecture, adding the new Main Processor 3008N. Therefore, this table reflects a tabulation of primary V&V records for the V10 platform changes as described in this document.

This summary report includes **ALL** releases for the complete commercial Tricon product line. This summary report is **not** limited to product that is listed on the NQEL only. Tricon V10.2.1 was the platform version qualified during the V10 Qualification Project and is the only V10 version listed on the below table as being Nuclear qualified (and listed on the NQEL).

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Table 1: V&V Summary Report Tricon V9.6 – Tricon V10.2.1 Releases

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Table 2: Column legend

This table provides a brief description of the information provided in each column of Table 1 in this summary.

Column	Description
Major/Maintenance Release	Release identifier. Vx.y.z: x is the Major release number, y is the Revision number, and z is the Maintenance release number. (EDM 20.00)
Date	Date the Software Release Definition (SRD) was released.
Applicable V&V plans	Listing of the document number for the applicable V&V Plans.
Major Procedures executed	Listing of the major procedures that we executed as part of the formal Validation of the release.
Software release definition	The software Release Definition is the document that describes what is being released. It also contains information on compatibility, included bug fixes, and/or functional enhancements.
Release content summary	Major reason why the release was needed. This Column mostly refers to I/O Modules, Communication modules, Main Processor modules and their Firmware. See Table 3
V&V report	Pointer to the location of the V&V report. Historically V&V reports were kept in hardcopy only. Since V10.2 all reports are kept in electronic format only in our Synergy source control system database. The hardcopy is currently being scanned.

Table 3: Acronym Legend and Cross Reference

This table provides a cross reference between the Firmware acronyms (EEPROM) used in the release content summary column of table 1 and the actual Tricon Model number. Firmwares labeled "included in the build" are not in EEPROM. They are downloaded to Flash Memory. Model numbers ending with an N are included on the V10 NQEL.

Name / Description		Model#	Firmware Acronym	
			V9.5.3	V10.2.1
ACM	Advanced Comm. Module	4609N	ACMX	N/A
1.0 AI	0-10V DC	3701N, 3701N2	AI/NITC	AI/NITC
AI	0-5/0-10V DC	3703EN	EIAI/ITC	EIAI/ITC
2.0 AI	0-5V DC	3700AN	AI/NITC	N/A
AI	DC Coupled Thermocouple	3706AN	AI/NITC	N/A
AI	0-5/0-10V DC coupled, commoned	3704EN	HDI	N/A
AI	Isolated Thermocouple	3708EN	EIAI/ITC	EIAI/ITC

Name / Description	Model#	Firmware Acronym	
		V9.5.3	V10.2.1
AI Differential Analog Input, 32 points	3721N	N/A	Included in the build
AO 4-20	3805EN, 3805HN	EAO	EAO
DI 115V AC/DC HiKV	3501TN, 3501TN2	EDI	EDI
DI 24/48V DC	3504EN	HDI	N/A
DI 24V AC/DC	3503EN, 3503EN2	EDI	EDI
DI 24V DC Low Threshold	3505EN	EDI	N/A
3.0 DI 48V AC/DC	3502EN, 3502EN2	EDI	EDI
DO 115V AC non Commoned	3601TN	EDO	EDO
DO 120V DC Supervised HiKV	3623TN	TSDO2	TSDO2
DO 120V DC Commoned HiKV	3603TN	TSDO	TSDO/HVDO
DO 24V DC non Commoned	3604EN	EDO	N/A
DO 24V DC Supervised	3624N	TSDO2	N/A
DO 48V DC non Commoned	3607EN	EDO	EDO
DO 24V DC Supervised, 32 points	3625, 3625N	N/A	DO
EICM Enhanced Intelligent Communication Module	4119AN	ICM + IICX(A)	N/A
MP EMP II	3006, 3006N		N/A
MP EMP III	3008, 3008N	N/A	Included in the build: ETSX IOCCOM
NCM Network Interface Module	4329N	ICM + NCMGX	N/A
PI Pulse Input	3510N	PI	N/A
PI Pulse Input	3511N	N/A	PI
RO Dry Contact	3636TN	ERO	ERO
RXM Primary Single Mode Fiber	4210N	RXM	N/A
RXM Primary	4200N	N/A	RXM

Name / Description		Model#	Firmware Acronym	
			V9.5.3	V10.2.1
RXM	Remote Single Mode Fiber	4211N	RXM	N/A
RXM	Remote	4201N	N/A	RXM
TCM	Tricon Communication Module	4352AN	N/A	Included in the build; TCM

Table 4: Other Abbreviations used in table 1

Abbreviation	Meaning
CR	Change Request – a Synergy Database record
PDR	Product Discrepancy report – a Synergy database record
SCAO	Servo Controller Analog Output Module (bi-polar)
PAN	Product Alert Notice
TAB	Technical Advisory Bulletin
Bug	Generic term for a product discrepancy usually reported in a PDR/PER
PER	Product Enhancement Request – a Synergy database record.
NGIO	Next Generation I/O modules (AI 3721N and DO 3625N)